APPLICATION NO. 09/846.410

TITLE OF INVENTION: Multiple Data Rate Hybrid Walsh Codes for CDMA

INVENTOR: Urbain A. von der Embse

Clean version of how the CLAIMS will read

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CLAIMS

WHAT IS CLAIMED IS:

Claim 1. (cancelled)

Claim 2. (cancelled)

Claim 3. (cancelled)

Claim 4. (cancelled)

Claim **5**. (currently amended) A method for generation of hybrid Walsh complex orthogonal codes for CDMA, said method comprising the steps:

classify the N=2^M N-chip Walsh codes into even codes and odd codes according to their even and odd properties about their code centers for integer M,

said Walsh codes by definition are the {+1,-1} valued N orthogonal Hadamard codes re-ordered according to their sequency values where sequency is the average rate of phase changes over each N chip code length,

classify the N N-sample discrete real Fourier transform codes into even codes and odd codes and re-order said codes according to increasing frequency,

construct a one-to-one correspondence of said N real Walsh codes with said N real Fourier transform codes such that sequency corresponds to frequency, even codes correspond to even codes, and odd codes correspond to odd codes,

construct a mapping which uses said N real Fourier codes for the

real and imaginary axis codes of the N N-sample discrete complex Fourier transform (DFT) codes and,

use said mapping combined with said correspondence to generate the real and imaginary axis component codes of said hybrid Walsh codes $\tilde{W}(c)$ for code index c=0,1,2,. . .,N-1 as re-orderings of said real Walsh codes W(c) for c=1,2,. . .,N-1 defined by the equations

$$
\begin{aligned}
&\text{for } c = 0, && \tilde{W}(c) = W(0) + jW(0),\\
&\text{for } c = 1,2,\ldots,N/2-1, && \tilde{W}(c) = W(2c) + jW(2c-1),\\
&\text{for } c = N/2, && \tilde{W}(c) = W(N-1) + jW(N-1)), \text{ and}\\
&\text{for } c = N/2+1,\ldots,N-1, && \tilde{W}(c) = W(2N-2c-1) + jW(2N-2c).
\end{aligned}
$$

Claim **6**. (currently amended) A method for generation of generalized hybrid Walsh codes for CDMA from code sets which include said hybrid Walsh, said Hadamard, said Walsh, said DFT, and pseudo-noise PN, said method comprising:

tensor product also called Kronecker product is used to construct said codes,

direct product is used to construct said codes,

functional combining is to construct said codes and,

combinations of tensor products, direct products, and functional combining are used to construct said codes.

Claim **7**. (currently amended) A method for mapping multiple data rate user symbols onto the code vectors of said codes in claime **5** and **6**, said method comprising the steps:

assign said users with like data symbol rates to the M groups $u_{M-1},u_{M-2},. . .,u_1,u_0$ of users with the respective symbol rates 1/NT,2/NT,. . .,2/T in units of data symbols per second where N=2^M is the number of code chips in said code block, and number of N-chip length codes, and number of user

data symbols, M is the number of said user groups and said code rates in the menu, 1/T is the code chip rate in chips per second,

in said assignment said lowest available symbol rate 1/NT user requires 1 N-chip code to support the data rate, said 2/NT user requires 2 N-chip codes, . . ., and said 2/T user requires N/2 N-chip codes,

generate the N data symbol index $d=d_0+2d_1+4d_2+...+(N/2)d_{M-1}$ and partition said data symbol index into M fields d_{M-1}, $d_{M-2}d_{M-1}$, . . ., $d_1d_2\cdots d_{M-2}d_{M-1}$, $d_0d_1d_2\cdots d_{M-2}d_{M-1}$ which fields respectively are indexed over the available number 2,4,. . ., N/2,N of data rate users for each data symbol rate in said menu 1/2T,1/4T,. . .,1/NT symbols per second respectively,

assign said data symbol indices in field d_{M-1} to said users in said group u_{M-1}, assign said data symbol indices in field $d_{M-2}d_{M-1}$ to said users in said group u_{M-2}, . . ., assign said data symbol indices in field $d_1d_2\cdots d_{M-2}d_{M-1}$ to said users in said group u_1, and finally assign said data symbol indices in field $d_0d_1d_2\cdots d_{M-2}d_{M-1}$ to said users in said group u_1,

assign said data symbol index $d=d_0+2d_1+4d_2+...+(N/2)d_{M-1}$ to said N-chip code vectors and,

said assigments define the mapping of said user symbols for data rates from said menu 1/NT,2/NT,. . .,2/T symbols per second onto said N-chip code vectors.

Claim **8**. (currently amended) Wherein said hybrid Walsh codes in claims **5** have a fast encoding algorithm, comprising the steps:

use said index fields in claim **7** to arrange the input data symbol set in the format $Z(d_0, d_1, . . ., d_{M-2}, d_{M-1})$ corresponding to said $d=d_0+2d_1+4d_2+...+(N/2)d_{M-1}$,

implement pass 1 of said fast encoding algorithm by multiplying

said Z by the kernal $[(-1)^{\wedge}dr_0 n_{M-1}+j(-1)^{\wedge}di_0\ n_{M-1}]$ and summing over $dr_0, di_0=0,1$ to yield the partially encoded symbol set $Z(n_{M-1}, d_1, \ldots, d_{M-2}, d_{M-1})$ where $dr_0=cr(d_0)$ and $cr(d)$ is the real axis code for d, $di_0=ci(d_0)$ where $ci(d)$ is the imaginary axis code for d, and n_{M-1} is a binary code chip coefficient in said code chip indexing $n = n_0+2n_1+\ldots+(N/4)n_{M-2}+(N/2)n_{M-1}$,

implement passes $m=2,3,\ldots,M-1$ of said fast encoding algorithm by multiplying $Z(n_{M-1}, n_{M-2}\ldots, n_{M-m+1}, d_{m-1}, \ldots, d_{M-2}, d_{M-1})$ by the kernal $[(-1)^{\wedge}dr_{m-1}(n_{M-m}+n_{M-m+1})+j(-1)^{\wedge}di_{m-1}(n_{M-m}+n_{M-m+1})]$ and summing over $dr_{m-1}, di_{m-1}=0,1$ to yield the partially encoded symbol set $Z(n_{M-1}, n_{M-1}, n_{M-2}\ldots, n_{M-m}, d_m, \ldots, d_{M-2}, d_{M-1})$,

implement pass M of said fast encoding algorithm by by multiplying $Z(n_{M-1}, n_{M-2}\ldots, n_2, n_1, d_{M-1})$ by the kernal $[(-1)^{\wedge}dr_{M-1}(n_0+n_1)+j(-1)^{\wedge}di_{M-1}(n_0+n_1)]$ and summing over $dr_{M-1}, di_{M-1}=0,1$ to yield the encoded symbol set $Z(n_{M-1}, n_{M-1}, n_{M-2}\ldots, n_2, n_1, n_0)$, and

reorder the encoded symbol set in the ordered output format $Z(n_0, n_1, \ldots, n_{M-2}, n_{M-1})$.

Claim **9**. (currently amended) Wherein said hybrid Walsh codes in claims **5** have a fast decoding algorithm, comprising the steps:

implement pass 1 of said fast decoding algorithm by multiplying said $Z(n_0, n_1, \ldots, n_{M-2}, n_{M-1})$ from claim **8** by the kernal $[(-1)^{\wedge}n_0 dr_{M-1}+j(-1)^{\wedge}n_0 di_{M-1}]$ and summing over $n_0=0,1$ to yield the partially decoded symbol set $Z(d_{M-1}, n_1, \ldots, n_{M-2}, n_{M-1})$,

implement passes $m=2,3,\ldots,M-1$ of said fast encoding algorithn by multiplying $Z(d_{M-1}, d_{M-2}\ldots, d_{M-m+1}, n_{m-1}, \ldots, n_{M-2}, n_{M-1})$ by the kernal $[(-1)^{\wedge}n_{m-1}(dr_{M-m}+dr_{M-m+1})+j(-1)^{\wedge}n_{m-1}(di_{M-m}+di_{M-m+1})]$ and summing over $n_{m-1}=0,1$ to yield the partially decoded symbol set

$Z(d_{M-1}, d_{M-1}, d_{M-2} \ldots, d_{M-m}, n_m, \ldots, n_{M-2}, n_{M-1})$,

implement pass M of said fast decoding algorithm by

by multiplying $Z(d_{M-1}, d_{M-2} \ldots, d_2, d_1, n_{M-1})$ by the kernal $[(-1)\hat{}n_{M-1}(dr_0 + dr_1)+j(-1)\hat{}n_{M-1}(di_0 + di_1)]$ and summing over $n_{M-1}=0,1$ and rescaling by dividing by 2N to yield the decoded symbol set

$Z(d_{M-1}, d_{M-1}, d_{M-2} \ldots, d_2, d_1, d_0)$, and

reorder the decoded symbol set in the ordered output format

$Z(d_0, d_1, \ldots, d_{M-2}, d_{M-1})$.